ST com STEVAL-IOD04KT1 Microelectronics Multiple Function Sensor User Guide

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Introduction

STSW-IOD04K is a software package, which lets you enable IO-Link communication between STEVAL-IOD004V1 (included in the STEVAL-IOD04KT1 but not available for separate sale) and an IO-Link master, through the L6364W transceiver. Based on the STM32CubeHAL, the STSW-IOD04K extends STM32Cube. It provides a board support package (BSP) for IO-Link communication based on a demo-stack library that manages data coming from the internal L6364W temperature sensor and the two on-board MEMS industrial sensors: IIS2MDC (high accuracy, ultra-low-power, 3-axis digital output magnetometer) and ISM330DHCX (always-on 3D accelerometer and 3D gyroscope).
The architecture of this application software facilitates the integration with other STM32Cube-based software to create examples for the most common application technologies. Included libraries enable functions for a real and usable system for developers. Hardware drivers and abstract low-level details allow the middleware components and applications to access data in a hardware-independent manner. The middleware libraries include an ST proprietary IO-Link demo-stack. You can use the STSW-IOD04K software package in different integrated development environments (IDEs): IAR, Keil, and STM32CubeIDE. It also includes the IODD file to be uploaded onto the user's IO-Link master.

Getting started

Overview

STSW-IOD04K expands STM32Cube functionality. The software package enables the IO-Link data transfer of industrial sensors on the STEVAL-IOD004V1 towards an IO-Link master connected through an IO-Link connection. The key package features are:

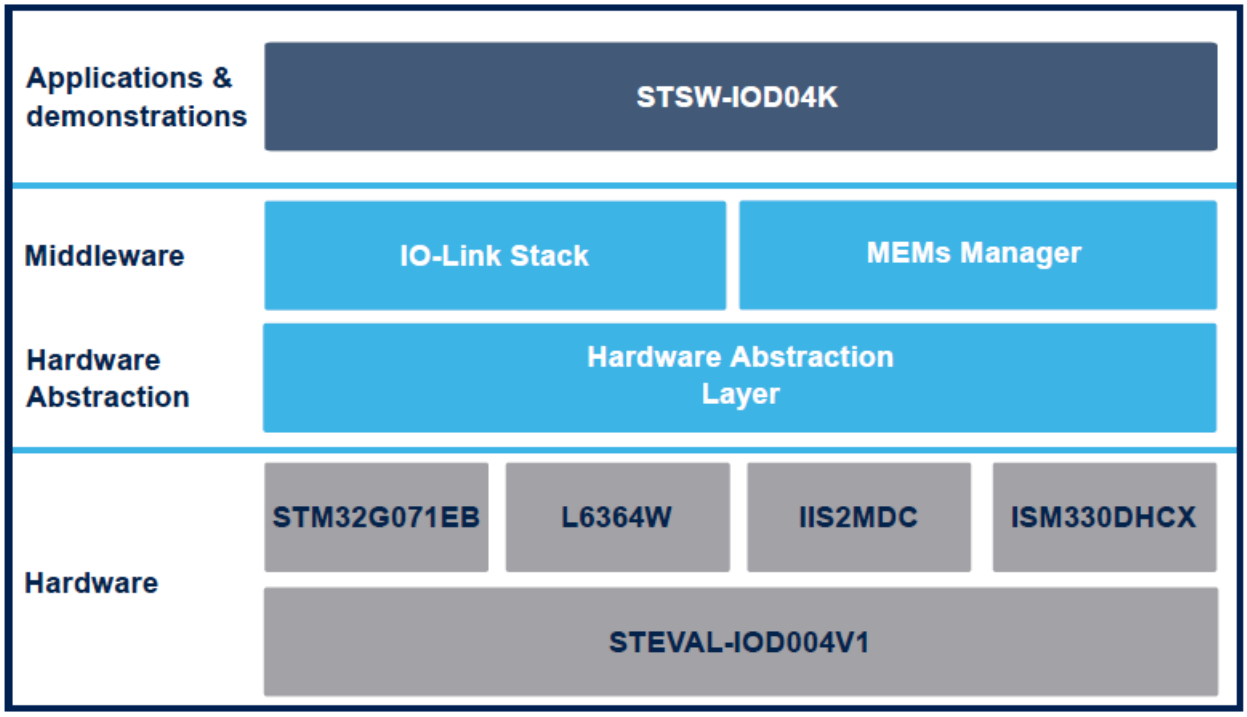
- Firmware package to build IO-Link device applications based on the STM32G071EB microcontroller
- Middleware libraries featuring IO-Link device demo-stack for L6364W to manage IIS2MDC and ISM330DHCX MEMS sensors
- Ready-to-use binary for IO-Link device sensor data transmission
- Easy portability across different MCU families, thanks to STM32Cube
- Free, user-friendly license terms

Architecture

The application software accesses the STEVAL-IOD004V1 through the following software layers:

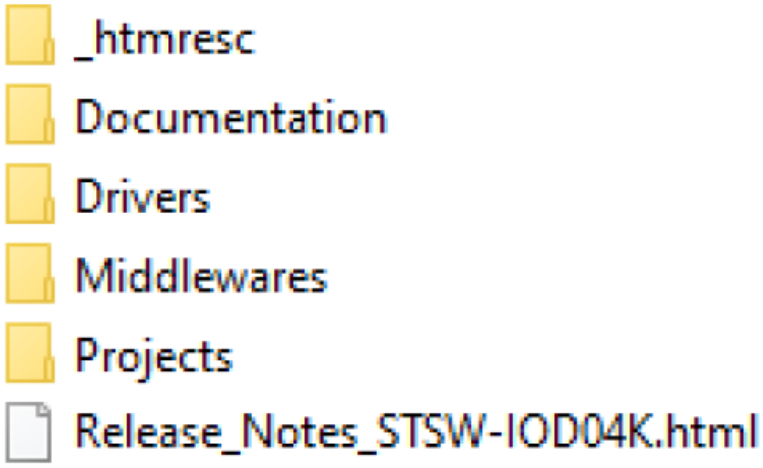
- STM32Cube HAL layer, which provides a simple, generic, multi-instance set of application programming interfaces (APIs) to interact with the upper application, library, and stack layers. It has generic and extension APIs and is directly built around a generic architecture. It allows successive layers like the middleware layer to implement functions without requiring specific hardware configurations for a given microcontroller unit (MCU). This structure improves library code reusability and guarantees an easy portability on other devices.
- Board Support Package (BSP) layer, which supports all the peripherals on the board except the MCU. This limited set of APIs provides a programming interface for certain board-specific peripherals like the LED, the user button, etc. This interface also helps in identifying the specific board version.

Figure 1. STSW-IOD04K software architecture



Folders

Figure 2. STSW-IOD04K folder structure



The software package includes the following folders:

- Documentation: a compiled HTML file generated from the source code detailing the software components and APIs (one for each project).
- Drivers: HAL drivers and board-specific drivers for each supported board or hardware platform, including those for the on-board components, and the CMSIS vendor-independent hardware abstraction layer for the ARM Cortex-M processor series.
- Middlewares: libraries and protocols featuring IO-Link mini-stack and sensors management.
- Projects: sample application implementing an industrial IO-Link multi-sensor node. This application is provided for the STM32G071EB microcontroller for three development environments: IAR Embedded Workbench for ARM, RealView Microcontroller Development Kit (MDK-ARM-STR) and STM32CubeIDE.

APIs
Detailed technical information with full user API function and parameter description are in a compiled HTML file in the “Documentation” folder.

Sample application description
The Projects folder provides the sample application, which uses the STEVAL-IOD004V1 with the L6364W transceiver, and the ISM330DHCX/IIS2MDC industrial sensors.
Ready-to-build projects are available for multiple IDEs. You can upload one of the binary files of the STSW-IOD04K through STM32CubeProgrammer or the programming feature of your IDE. To power the STEVAL-IOD004V1 and flash the firmware, you can choose one of the options below:

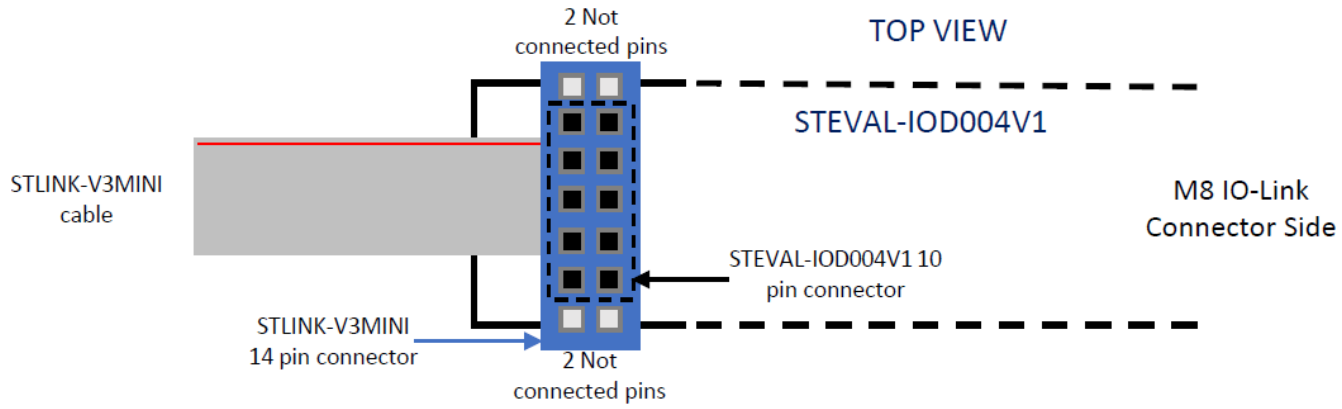
- Connect your MCU programmer (for example, STLINK-V3MINI) to the board through connector J1; power up the board by the 24 V supplied from an IO-Link master; on your programmer, select the binary file to flash and then proceed programming the MCU.

Note
For the above procedure, you need two USB ports (one for the programmer, the other for the IO-Link master).

- Connect your MCU programmer (for example, STLINK-V3MINI) to the board through connector J1; supply the MCU by a 3.3 V power supply connected to the board through J2 (pin 2 = GND; pin 4 = 3.3 V); on your programmer, select the binary file to flash and then program the MCU.

The STLINK-V3MINI programmer can be connected to the STEVAL-IOD004V1 by J1 (10 ways, two rows) through the 14-pin flat cable included in the kit: two pins on the right and left sides of the cable remain unconnected. Looking at the board top side and leaving the IO-Link M8 connector on your right, the cable must be connected so that the red line is on the top, as shown below.

Figure 3. STEVAL-IOD004V1 and STLINK-V3MINI – connection diagram



To evaluate the STSW-IOD04K firmware, upload the IODD file on the control tool of your IO-Link master and connect it to the STEVAL-IOD004V1 by the IO-Link cables and adapters included in the kit, or by any other compatible cable. You can use any other IO-Link master v1.1 with the related control tool. In the example of Section 2.2, the IO-Link master is the P-NUCLEO-IOM01M1, the related control tool is the IO-Link Control Tool developed by TEConcept (ST partner) and the connection is completed by an M12 socket to free wire cable (Katlax p/n CBF12-S44N0-1.5BPUR).

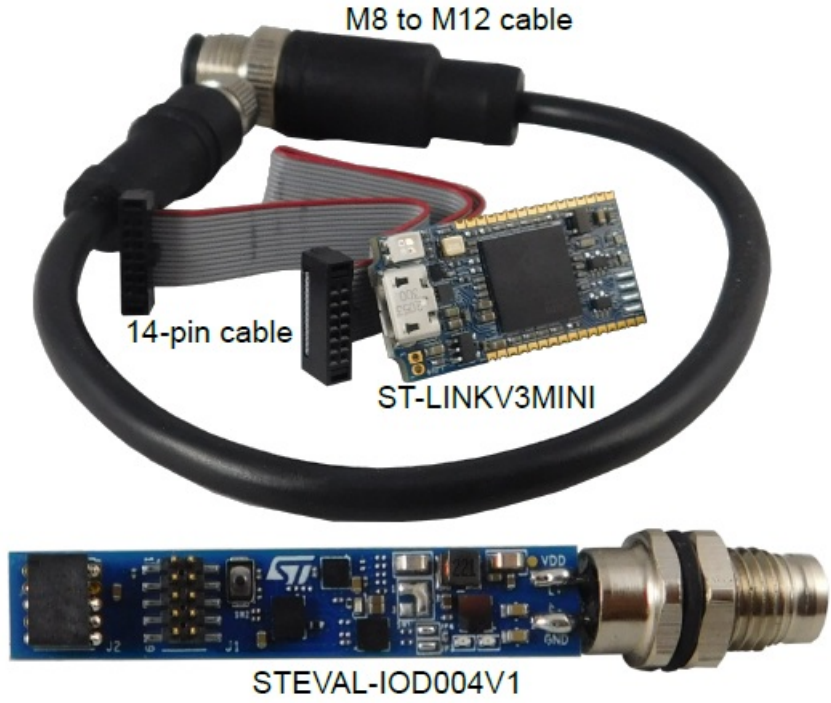
System setup guide

Hardware description

STEVAL-IOD04KT1 evaluation kit

The STEVAL-IOD04KT1 is a reference design kit that exploits the features of the L6364W IO-Link dual-channel device transceiver. The kit consists of the STEVAL-IOD004V1 main board (not available for sale), the STLINK-V3MINI programmer and debugger tool, a 14-pin flat cable, and an M8 to M12 standard industrial connector adapter. The kit acts as a modern smart industrial sensor to be connected to a master IO-Link hub (or a suitable PLC interface). The power supply for the MCU, sensors, and other logic devices derives from the DC-DC converter controller embedded in the L6364W. The on-board STM32G071EB microcontroller runs an IO-Link demo stack v.1.1, which controls the IO-Link communication, and the software code that manages the L6364W transceiver and the MEMS industrial sensors. The tiny dimensions of the main board have been achieved thanks to the small sizes of the CSP package options of L6364W and STM32G071EB. Connect the main board to an IO-Link master via the adapter and the M8 connector included in the kit for normal operation. Connect the same board to the STLINK-V3MINI through the flat cable only if you want to program the STM32G071EB with a new firmware.

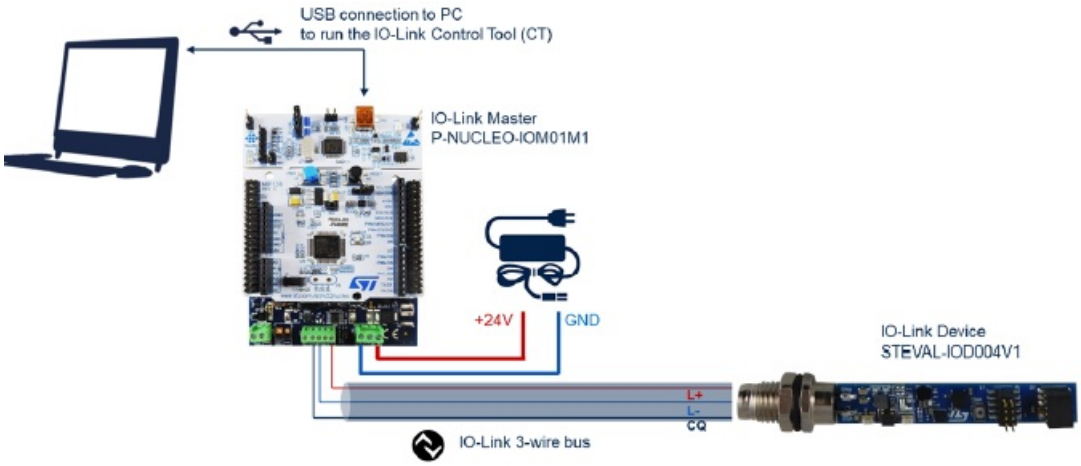
Figure 4. STEVAL-IOD04KT1 evaluation kit



Hardware setup

The following steps explain how to control the STEVAL-IOD004V1 through the P-NUCLEO-IOM01M1.

- Step 1. Connect the P-NUCLEO-IOM01M1 to the STEVAL-IOD004V1 through three wires (L+, L-/GND, and CQ). The STEVAL-IOD04KT1 includes an M8 (four-way socket) to M12 (five-way plug) connector to easily interface the STEVAL-IOD004V1 to any IO-Link master with an M12 (socket) connector. The easiest way to connect the STEVAL-IOD004V1 to the P-NUCLEO-IOM01M1 is to use a cable with M12 (four- or five-way socket) on one side and free wires on the other side (for example, Katlax p/n CBF12-S44N0-1.5BPUR).
- Step 2. Connect the P-NUCLEO-IOM01M1 to a 24 V/1 A power supply. The following figure shows how to connect the P-NUCLEO-IOM01M1 and the STEVAL-IOD004V1 running the STSW-IOD04K.



- Step 3. Launch IO-Link Control Tool on your laptop/PC.
- Step 4. Connect the P-NUCLEO-IOM01M1 by mini-USB cable to your laptop/PC running the IO-Link Control Tool.

  NOTE

  The steps from 5 to 13 refer to actions to perform in the IO-Link Control Tool.
- Step 5. In the IO-Link Control Tool, click on [Select device] and follow the instructions to upload

STMicroelectronics-STEVAL-IOD004V1-38kBd-20210429-IODD1.1.xml or STMicroelectronics-STEVAL-IOD004V1-230kBd-20210429-IODD1.1.xml, according to COM2 or COM3 choice, in the IODD directory of the software package.

- Step 6. Connect the master by clicking on the green icon (top-left corner).
- Step 7. Click on [Power ON] to supply the STEVAL-IOD004V1. The red LED on the STEVAL-IOD004V1 blinks.
- Step 8. Click on [IO-Link] to initiate IO-Link communication. The green LED on the STEVAL-IOD004V1 blinks.

  NOTE

  By default, the communication starts with ISM330DHCX configured as accelerometer.
- Step 9. Plot the data collected by the ISM330DHCX accelerometer by clicking on [Plot].
- Step 10. To activate the data exchange with another sensor, go to [Parameter Menu]>[Process Input Selection].
  - Step 10a. Double-click on the sensor name (green text).
  - Step 10b. Select the desired sensor from the available choices.
  - Step 10c. Click on [Write Selected] to align the master and device. The procedure is completed when the name of the selected sensor becomes green, as shown below.

Figure 6. IO-Link Control Tool view (example)

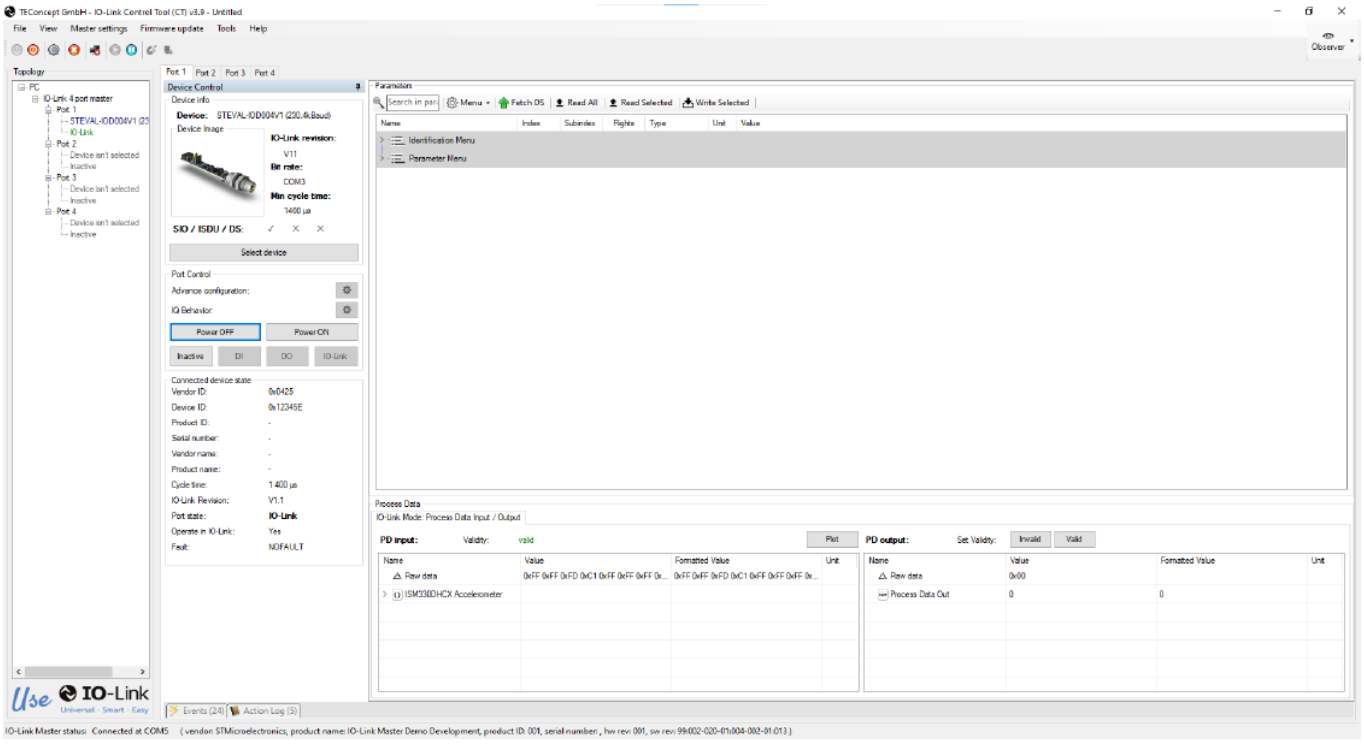
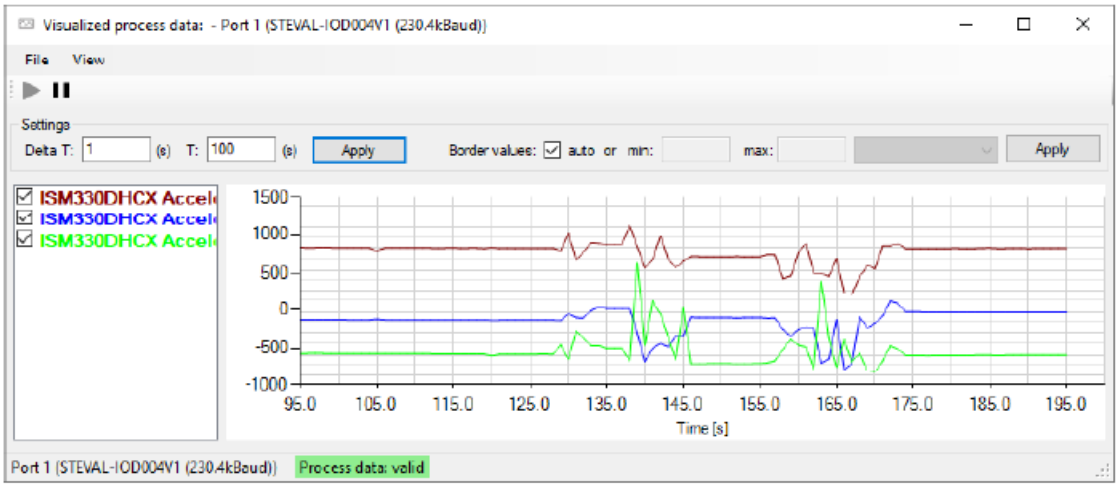


Figure 7. IO-Link Control Tool view – process data plot



- When you finish your evaluation session, follow the additional steps below.
- Step 11. Click on [Inactive] to stop IO-Link communication.
- Step 12. Click on [Power Off] to stop the IO-Link master from supplying the IO-Link device.
- Step 13. Click on [Disconnect] to stop the communication between IO-Link Control Tool and P-NUCLEO-IOM01M1.
- Step 14. Disconnect the mini-USB cable from the P-NUCLEO-IOM01M1.
- Step 15. Disconnect the 24 V supply from the P-NUCLEO-IOM01M1.

Software setup
To set up a suitable development environment for the creation of IO-Link applications for the STM32G071EB and L6364W, you need:

- STSW-IOD04K firmware and related documentation available on www.st.com;
- one of the following developments toolchain and compilers:
  - IAR Embedded Workbench for ARM® toolchain
  - Keil
  - STM32CubeIDE plus ST-LINK/V2

Revision history

Table 1. Document revision history

Date	Revision	Changes
27-Oct-2021	1	Initial release.

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Documents / Resources

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References

- STMicroelectronics: Our technology starts with you
- STMicroelectronics Trademark List - STMicroelectronics
- STMicroelectronics: Our technology starts with you
- IIS2MDC - High accuracy, ultra-low-power ,3-axis digital output magnetometer - STMicroelectronics
- ISM330DHCX - iNEMO inertial module with Machine Learning Core, Finite State Machine with digital output for industrial applications. - STMicroelectronics
- L6364 - Dual channel transceiver IC for SIO and IO-Link sensor applications - STMicroelectronics
- P-NUCLEO-IOM01M1 - STM32 Nucleo pack for IO-Link master with IO-Link v1.1 PHY and stack - STMicroelectronics
- ST-LINK/V2 - ST-LINK/V2 in-circuit debugger/programmer for STM8 and STM32 - STMicroelectronics
- STEVAL-IOD04KT1 - Industrial smart sensor kit based on L6364W dual IO-Link device transceiver - STMicroelectronics
- STLINK-V3MINI - STLINK-V3 compact in-circuit debugger and programmer for STM32 -

STMicroelectronics

- STM32G071EB - Mainstream Arm Cortex-M0+ MCU with 128 Kbytes of Flash memory, 36 Kbytes RAM, 64 MHz CPU, 4x USART, timers, ADC, DAC, comm. I/F, 1.7-3.6V - STMicroelectronics
- STSW-IOD04K - Software pack for STEVAL-IOD04KT1 with IO-Link stack v1.1, IODD, and control software for industrial sensors - STMicroelectronics
- STM32Cube - Discover the STM32Cube Ecosystem - STMicroelectronics
- STM32CubeIDE - Integrated Development Environment for STM32 - STMicroelectronics
- STM32CubeProg - STM32CubeProgrammer software for all STM32 - STMicroelectronics